intense electrical oscillations which pass through the coil shown, and violently agitate the electrified molecules of the air. By this means a strong affinity is created between the two normally indifferent constituents of the atmosphere, and they combine readily, even if no further provision is made for intensifying the chemical action of the discharge.

Under certain conditions the atmosphere, which is normally a high insulator, assumes conducting properties, and so becomes capable of conveying any amount of electrical energy. The discovery of the conducting properties of the air, though unexpected, was only a natural result of experiments in a special field carried on for some years previously. It was during 1889 that certain possibilities, offered by extremely rapid electrical oscillations, led to the design of a number of special machines adapted for their investigation. One of the earliest observations made with these new machines was that electrical oscillations of an extremely high rate act in an extraordinary manner upon the human organism. Thus, for instance, powerful electrical discharges of several hundred thousand volts, which at that time were considered absolutely deadly, could be passed through the body without inconvenience or hurtful consequences. Another observation was that by means of such oscillations light could be produced in a novel and more economical manner, which promised to lead to an ideal system of electric illumination by vacuum-tubes, dispensing with the necessity of renewal of lamps or incandescent filaments, and possibly also with the use of wires in the interior of buildings.

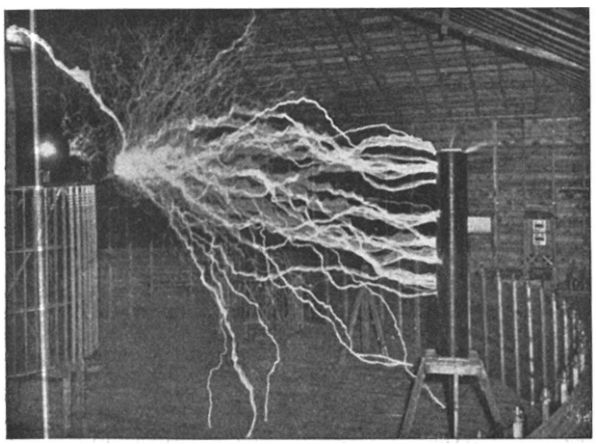

FIG. 2.—The coil, partly shown in the photograph, creates an alternating current of electricity at the rate of 100,000 alternations per second. The discharge escapes with a deafening noise, striking an unconnected coil 22 feet away, and creating such an electrical disturbance that sparks an inch long can be drawn from a water-main at a distance of 300 feet from the laboratory.

The investigations led to other valuable observations and results, one of the more important of which was the demonstration of the practicability of supplying electrical energy through one wire without return. To what a degree the appliances have been perfected since the demonstrations in 1892, when the apparatus was barely capable of lighting one lamp, will appear from the fact that as many as four or five hundred lamps have been lighted in this manner.

The success of this method of transmission suggested that the earth could be used as a conductor, thus dispensing with wires. The earth was regarded as an immense reservoir of electricity, which could be disturbed effectively by a properly designed electrical machine. Accordingly efforts were directed toward perfecting a special apparatus which would be highly effective in creating a disturbance of electricity in the earth, and a novel kind of transformer or induction-coil, particularly suited for this special purpose, was designed. By means of this apparatus, it is practicable, not only to transmit minute amounts of electrical energy for operating delicate electrical devices, but also electrical energy in appreciable quantities.

However extraordinary the results exemplified by Fig. 2 may appear, they are but trifling compared with those which are attainable by apparatus designed on these same principles. Electrical discharges have been produced, the actual path of which, from end to end, was probably more than one hundred feet long; but it would not be difficult to reach lengths one hundred times as great. Electrical movements occurring at the rate of approximately one hundred thousand horse-power have been obtained, but rates of one, five, or ten million horse-power are easily practicable.

The most valuable observation made in the course of these investigations was the extraordinary behaviour of the atmosphere toward electric impulses of excessive electromotive force. The experiments showed that the air at the ordinary pressure became distinctly conducting, and this opened up the wonderful prospect of transmitting large amounts of electrical energy for industrial purposes to great distances without wires, a possibility which, up to that time, was thought of only as a scientific dream. Further investigation revealed the important fact that the conductivity imparted to the air by these electrical impulses of many millions of volts increased very rapidly with the degree of rarefaction, so that air strata at very moderate altitudes, which are easily accessible, offer, to all experimental evidence, a perfect conducting path, better than a copper wire, for currents of this character.

The experiments have indicated that, with two terminals maintained at an elevation of not more than thirty thousand to thirty-five thousand feet above sea-level, and with an electrical pressure of fifteen to twenty million volts, the energy of thousands of horse-power can be transmitted over distances which may be hundreds and, if necessary, thousands of miles. Investigations are now being carried on with the object of reducing considerably the height of the terminals now required.

SOME SCIENTIFIC ASPECTS OF TRADE.

A REPORT on the trade and commerce of Leghorn, for the year 1899, by Mr. Vice-Consul Carmichael, has just been received at the Foreign Office and published as No. 2714 of the Annual Series. The following extracts from the report are of interest as showing the various points at which scientific work and knowledge touch industry.

The proportion of sulphate of copper imported from Great Britain in 1898 was 96 per cent.; it had in 1899 fallen to 76 per cent. The explanation of this unwelcome fact appears to be due to keen United States competition. Italian manufacture is likely to become an even more formidable danger in the near future. Manufacturers appear as a rule to have gone to England for the greater part of the raw material, and that of itself was a handicap. Now, however, the flourishing and influential Società Metallurgica of Leghorn is busily erecting the necessary plant for the manufacture of sulphate of copper on a large scale. Italy produces some 26,000 tons of copper annually, and it is said that the company can depend upon securing its material at home. Should this be the case it will at once be seen how formidable a competitor is entering the field. In any case the more satisfactory days of the English trade in sulphate seem to be over.

As this series of reports is yearly obtaining a larger circulation it may perhaps be necessary to state that the wood from which briar pipes are made is not the root of the briar rose, but the root of the large heath known in botany as the *Erica arborea*. Our "briar" is but a corruption of the French "bruyère." The briar-root industry has had a somewhat curious history. First begun in the Pyrenees some 50 years ago, it travelled along the French Riviera and the Ligurian coast (taking Corsica by the way) to the Tuscan Maremma, and has now reached Calabria in the south, which is at present its most flourishing centre. By the very nature of the business, when a certain district has been exhausted of all its roots, the industry must come to an end there, and I have heard the opinion expressed that the Italian branch of it cannot last much more than another ten years. Leghorn has always been the centre of the export of Tuscan briar-root since the Maremma industry came into existence, but as the South Italian briar is of admittedly superior quality, a large quantity of the Calabrian root is also imported into Leghorn for selection and subsequent export.

The olive oil crop throughout Tuscany, small as it promised to be, has, I regret to say, been more than half destroyed by

the ravages of the olive fly. Hence the quantity of olive oil obtained this season in Tuscany has been insignificant, while the quality of most of it is distinctly inferior. A full crop of olive oil may be reckoned at a money value of some 10,000,000*l.*

The olive maggot—which subsequently develops into the olive fly—destroys the pulp of the fruit, and so potent are the ravages of this pest that it is capable of diminishing the yield of oil by one-half, and seriously injuring the quality of the remainder. It will therefore be seen that the fly may actually cause damage in one year amounting to 5,000,000*l.* Notwithstanding the urgency of the matter, no means of destroying the insect appear so far to have been discovered, nor has the State suggested any practical remedy. The subject is recommended to the notice of English men of science, as any discovery which should exterminate the plague ought certainly to be profitable. What seems to be wanted is that entomologists of experience should carefully study the habits of the fly with a view to finding out the hitherto undiscovered winter habitat. Then alone could proper steps be taken for its destruction. It has been hazarded with some likelihood that the winter habitat of the fly must be in the bark of the olive trees. If that were the case, all that would be needed would be to paint the trees during the winter with a simple solution of lime, which, though it might spoil the beauty of the Italian landscape, would rid the country of a very formidable enemy to its agricultural prosperity.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—Two University lectureships in experimental physics are now vacant. The appointment is for five years, and the stipend 50*l.* a year. Applications should reach the Vice-Chancellor by June 2.

The researches of Mr. L. N. G. Filon, advanced student, of King's College, in relation to certain problems in applied mechanics, have been approved as a qualification for the B.A. degree.

Sixty-three men and nineteen women have acquitted themselves so as to deserve honours in the Mathematical Tripos, Part I.

Honorary degrees will, on June 12, be conferred on the Earl of Rosse, F.R.S., Sir Benjamin Baker, F.R.S., Sir W. L. Buller, F.R.S., Prof. S. P. Langley, Prof. W. M. Flinders Petrie and Prof. H. Poincaré.

The graces for the establishment of a new special examination in agricultural science for the B.A. degree was opposed on May 24, but it was carried by a large majority. The first examination will take place at the end of the year.

ONE of the chief difficulties which has to be overcome by Technical Education Committees is the defective character of elementary education, respecting which lament is very general. Several instances of this difficulty are given in the current number of the *Record of Technical and Secondary Education.* The Durham committee have been compelled for some years to give financial assistance to preparatory classes now formed in all but twenty-one districts of the county. The committee have by such means paved the way for their new regulation of 1899 that there must be "the production of evidence of preparatory training on the part of all new applicants on whom attendance grants would be claimed." This action already appears to be having a satisfactory effect. The Cambridgeshire, Nottinghamshire and Staffordshire committees also deal at some length with the question of defective elementary education. The Cambridgeshire committee go so far as to say:—"The very backward state of elementary education has made it extremely difficult, if not impossible, to establish a system of technical education in the proper sense of the term." The Staffordshire committee speak of it in its relation to "the early age at which pupils leave the elementary schools," and this has thrown upon them "much elementary and preparatory work which otherwise would have been unnecessary." The importance of promoting the efficiency of the work of evening continuation schools cannot be too strongly urged, as they largely constitute the foundation of the work of Technical Education Committees and thus lead on to higher and specialised instruction.

SOCIETIES AND ACADEMIES.

LONDON.

Physical Society, May 25.—Prof. J. D. Everett, F.R.S., Vice President, in the chair.—Prof. S. P. Thompson showed some experiments illustrating the aberration called Coma. If a converging lens is placed obliquely in a parallel beam of light, instead of giving a point image, it produces unilateral distortion, and the bright central spot is accompanied by a pear-shaped tail, which is known as a coma. The direction in which this tail points depends upon the side of the lens which is presented to the light. With a concavo-convex lens the convex surface gives an inward pointing coma, and the concave surface an outward pointing coma. The existence of this phenomenon is due to unequal magnification from different zones of the lens, a fact which was shown by covering the lens with a zone-plate of three or four rings and viewing on a screen the distorted images of the several zones. The form of a coma varies greatly with the distance of the screen from the lens. A parallel beam of light which has passed obliquely through a convex lens is capable of producing some curious shadows. The shadow of a rod can be obtained as a circular spot, and that of a grating, made by stretching threads between two rods, as concentric circular rings. Prof. Thompson also showed a stringed model illustrating the paths of light-rays in the formation of a coma.—Mr. R. T. Glazebrook then read some notes on the measurement of some standard resistances. Three methods have been employed by the author for building up multiples of a standard resistance, such as a one-ohm coil. The first method consists in making as accurately as possible three three-ohm coils. These in parallel can be compared directly with the standard by Carey Foster's method. Their resistance in series is very approximately nine times that in parallel, and hence an accurate determination of a resistance about nine ohms can be obtained. If, then, this resistance is put in series with the standard, an accurately-known ten-ohm resistance is obtained. By a similar process, a hundred- or a thousand-ohm coil can be built up. The second method consists in calibrating a resistance-box. The one-ohm coils of the box are compared directly with the standard, and the other resistances determined accurately by a building-up process, using a subsidiary resistance-box. In comparing the high resistances, the difference between the two boxes may be so great as to send the balance off the bridge wire. In these cases the third method is employed. The equal arms of the bridge are accurately known, and one of them is shunted with a resistance, which need not be accurately known, until the reading is brought back on to the wire. The coils chiefly used throughout the experiments are made of platinum-silver.—Mr. J. J. Guest read a paper on the strength of ductile materials under combined stresses. The author throughout his experiments has used the "yield point" of a material as the true criterion of its strength, and has rejected the elastic limit as being modified by local yielding. At present, two theories are used in the calculation of strengths of materials. The first is that the material yields when one of the principal stresses reaches a certain amount. This theory, which was adopted by Rankine and is used by engineers in England and America, is not in accord with recent experiments. The second theory is that the material yields when the greatest strain reaches a certain amount. This was advocated by St. Venant, and is used by engineers on the Continent. Besides these there is a third theory of elastic strength, in which the condition of yielding is the existence of a shearing stress of a specific amount. In the case of a solid bar subjected to torsion, there is a variation in the strain from the axis outwards, and consequently the materials have been used in the form of thin tubes. This allows the application of an internal fluid pressure. The specimens were of steel, copper and brass, the state of set caused by drawing having been removed by annealing. The tubes were subjected to (1) torque, (2) torque and tension, (3) tension only, (4) tension and internal pressure, (5) torsion and internal pressure, and (6) internal pressure only. The axial elongation, the twist, and occasionally the circumferential strain were measured. Towards the end of the experiments observations were made on bending. The results disprove the maximum stress theory, and are at variance with the maximum strain theory. The maximum shearing stress developed, and the corresponding shearing strain were comparatively constant throughout the experiments, and no other simple relation between the stresses or strains was even approximately constant. The results